PTO 03-5203

Japanese Kokai Patent Application
No. Hei 10[1998]-321457

CERAMIC MULTILAYERED COMPONENT MANUFACTURING METHOD AND MANUFACTURING DEVICE

Shinji Takane, et al.

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. SEPTEMBER 2003
TRANSLATED BY THE RALPH MCELROY TRANSLATION COMPANY

JAPANESE PATENT OFFICE
PATENT JOURNAL (A)
KOKAI PATENT APPLICATION NO. HEI 10[1998]-321457

Int. Cl.[6]:	H 01 G 4/12 4/30
Filing No.:	Hei 9[1997]-133210
Filing Date:	May 23, 1997
Publication Date:	December 4, 1998
No. of Claims:	2 (Total of 7 pages; OL)
Examination Request:	Not requested

CERAMIC MULTILAYERED COMPONENT MANUFACTURING METHOD AND MANUFACTURING DEVICE

[Seramikku sekiso-buhin no seizo hoho oyobi seizo sochi]

Inventors:	Shinji Takane, et al.
Applicant:	000005083 Hitachi Metals, Ltd.

[There are no amendments to this patent.]

Claims

1. A ceramic multilayered component manufacturing method characterized in that in a ceramic multilayered component manufacturing method in which prescribed internal circuits are printed on ceramic green sheets with a substrate film cut into a prescribed size, and [the sheets] are layered and crimped together into a multilayered block, the ceramic green sheets with the substrate film are provided with positional references indicating prescribed relative relationship with the internal circuit, and the positional references are photographed using cameras during the printing process of the internal circuit and the process for layering the ceramic green sheets with the substrate film in order to measure the positions by means of image processing, and the positions of the sheets with the substrate film are corrected based on said information.

2. A ceramic multilayered component manufacturing device characterized in that in a ceramic multilayered component manufacturing device having a printing means which prints a prescribed internal circuit on a ceramic green sheet with a substrate film cut into a prescribed size and a layering means which layers the ceramic green sheets and crimps them into a layered multilayered block, a marking means which provides positional references indicating prescribed positional relation ship with the internal circuit on the ceramic green sheet with the substrate film, a first measurement controlling means which measures the positions of the aforementioned positional references in order to compute the differences between the measured values and prescribed values set, a positioning means which sets the ceramic green sheet to the internal circuit printing means by moving it in such a manner that the aforementioned differences are eliminated, a second measurement controlling means which measures the positions of the references provided on the respective ceramic green sheets in order to compute the differences between the measured values and prescribed values set, and a carrier means which carries the ceramic green sheets and sets them to the layering means in such a manner that the aforementioned differences are eliminated, are provided.

Detailed explanation of the invention

[0001]

Technical field of the invention

The present invention pertains to a manufacturing method and a manufacturing device for a ceramic multilayered component, such as a condenser, a piezoelectric element, an inductor, a transformer, and a filter, or a ceramic multilayered component created by combining them, in which circuits are formed on ceramic green sheets (will be referred to as a green sheet, hereinafter) using a thick-film printing method, for example, and these green sheets are crimped together, cut, normalized, and external electrodes are added.

[0002]

Prior art

In general, manufacturing of a ceramic multilayered component involves 2 processes, that is, one which utilizes a frame and another which does not utilize a frame. In either case, several 100s to several 1000s of products are formed on a single multilayered block and cut into [individual pieces] in order to achieve a mass-production effect. First, a conventional process utilizing a frame will be explained based on Figure 6. During a sheet formation process, a ceramic slurry of a dielectric or a magnetic material is coated to an even thickness on the substrate film (referred also to as carrier sheet or carrier film), such as a polyethylene terephthalate film, in order to form a 20 μm-500 μm thick green sheet Next, the green sheet is

peeled off the substrate film, cut into an prescribed size, and pasted onto a metallic frame whose center part is cut off in a rectangular [sic; square] shape (cutting-framing process). Next, an internal circuit is printed (internal circuit printing process) using said metallic frame as a positioning reference. The green sheet in the metallic frame with the unique circuit pattern printed on its primary plane in said manner is applied with crimping press in a prescribed sequence and positioned by the metallic frame; and only the green sheet is punched out. [The resulting green sheets] are layered and crimped to form a multilayered block (carrying-crimping process). Subsequently, ceramic multilayered components are created through a cutting process in which the multilayered block is cut into the shape of a chip, a degreasing process, a formalization process, and an external electrode formation process. As described above, during said processes, the metallic frame prevents printing deviations when printing the internal circuit on the green sheets and functions as a positioning jig for matching the patterns on the upper and the lower layers during the layering. When 100 μm or thinner green sheets are involved, it functions as a jig for preventing the green sheets from deforming and making their handling easier. However, when [the green sheets] are thinner than 50 μm, it is difficult to apply because the green sheet is broken when the green sheet is peeled from the substrate film.

[0003]

Next, non-frame process where no frame is utilized will be explained based on known examples. A multilayered ceramic electronic component manufacturing method in which a frame is used up to the halfway process is disclosed in Japanese Kokai Patent Application No. Hei 5[1993]-144688 (Publicly Known Example 1). In this case, after green sheets formed on a carrier sheet are cut into a prescribed size together with the carrier sheet and pasted to a metallic frame, electrodes are printed under said condition, the carrier sheet is punched out of the metallic frame subsequently, and positioning holes are created at the 4 corners at the same time. During the layering-crimping process, the aforementioned positioning holes are fitted onto positioning pins provided on a crimping mold, [the green sheets] are positioned properly and layered together, and the carrier sheet is peeled off after they are crimped together. In addition, a green sheet printing-layering method and a device to this end are disclosed in Japanese Kokai Patent Application No. Hei 5[1993]-182859 (Publicly Known Example 2). In this case, the positioning holes are punched out simultaneously with the cutting of the green sheet with the carrier film, [the green sheet] is carried onto an electrode printing table while holding it by inserting positioning pins of a carrier head into the aforementioned positioning holes and inserted into positioning holes provided at the positions corresponding to the positioning pins of said carrier head in order to position the green sheet with the carrier film properly, and electrodes are printed. During the layering process, the inverted green sheet with the carrier film printed with the

electrodes is carried onto a layering table while holding it by inserting positioning pins of another carrier head into its positioning holes, the positioning pins of the carrier head and the positioning pins provided on the layering table are brought into contact with each other, the green sheet with the carrier film is sucked using suction holes provided on the layering table, and [the green sheets] are layered together by fitting the positioning holes of the green sheet with the carrier film onto the positioning pins of the layering table. In the meanwhile, every time a green sheet with the carrier film is layered, the carrier film is peeled off. Subsequently, once a prescribed number of green sheets are layered, the positioning pins are withdrawn, and they are moved onto a press and crimped together.

[0004]

Currently, there is a demand that ceramic multilayered components with stable electrical characteristics, such as capacitance and inductance, with little variance be offered inexpensively. To attain stable characteristics, deviations of the printed internal circuit across the green sheets and shifting of the green sheets during their layering and crimping need to be reduced as much as possible. During the process involving the frame, because the frame functions as a positioning jig, highly accurate positioning can be achieved during the printing of the internal circuit. However, during the layering process, only the center part of the green sheet pasted to the frame is punched into a cavity created on a square lower mold using a square upper mold. Of the upper and the lower square molds, the cavity of the lower mold has a slightly greater clearance, and the edge part of the punch gets worn as the number of punching increases. Furthermore, because heated molds are used to crimp the green sheets together, the mold expands slightly due to thermal expansion. Due to said factors, it is difficult to keep the punching clearance using molds, and the layers are shifted as [the layered body of] the green sheets is pulled in the direction of a cutting line with the greatest clearance out of the edges cut along the 4 sides of the square when it is cut off the frame or as it moves freely while it is dropping onto another [layered body of] the green sheets layered previously in the cavity of the lower mold after it is cut. Furthermore, when the green sheet is upsized, the center part of the green sheet placed on the frame warps, so that the layering error gets intensified. Thus, 100 μm of shifting may be created between the upper-layer and the lower-layer green sheets during the layering-crimping process. In addition, in terms of productivity, there are problems that the cost for pasting the green sheet on the frame is required, and that a process for pasting it using an adhesive and a process for washing the frame to reuse it are also needed.

[0005]

On the other hand, in the case of Publicly Known Example 1 as a conventional example which does not utilize a frame, the electrode printing process is a frame-utilizing process, so that it is subject to the same problems as those described above. In addition, during the layering-crimping process, [the green sheet] is already punched out of the metallic frame, and accurate positioning is achieved using the green sheet with a carrier film created with positioning holes and by fitting said positioning holes onto positioning pins provided on the crimping mold. However, although the holes to be punched out on the compound body comprising the carrier film and the ceramic green sheet can be created highly precisely on the green sheet, they cannot be used as references for fitting because [the green sheet] is soft. Thus, the positioning is achieved by the carrier film. However, flashes are likely to be created at the edges of the holes of the carrier film, so that the precision of the hole diameter is poor. Therefore, the method in which the pins are inserted for positioning is subject to an error in that 100 μm or so of shifting may occur as described above. In particular, while it is difficult to fit multiple pins into holes accurately and automatically, no specific insertion method for positioning is described in said Publicly Known Example 1. In addition, because it is a mechanical positioning method, the positioning hole needs to be several millimeters in size, for example 3 mm, and a bigger green sheet is needed to said extent, so that the yield deteriorates.

[0006]

On the other hand, in Publicly Known Example 2, when the green sheet is carried, it is held by inserting the positioning pins into the positioning holes. Therefore, a size which allows the positioning hole to fit onto the positioning pin without any gap needs to be used. To this end, the same pitch as that of the positioning pin may be used for the positioning hole while making the diameter of the hole slightly smaller. However, it is impossible to use the same pitch for all positioning pins in each process. In addition, the thermal expansion rate of the compound body comprising the substrate film and the green sheet is greater than that of a metal by 1 digit, so that the pitch of the positioning pin and the pitch of the hole created on the green sheet are likely to shift from each other. Therefore, the positioning pin needs to be inserted into the hole firmly even when the pitches are shifted, so that the positioning hole is deformed always. Said deformation gets intensified as it is repeated during the electrode printing process, the sheet inverting process, and the layering process. The shifting of the green sheet is determined by the fitting precision of the positioning holes of the green sheet with the carrier film with respect the positioning pins on the layering table. The aforementioned deformation of the positioning hole is a major cause of shifting. In addition, although shifting of prints between the green sheets during the electrode printing is determined by the fitting precision of the positioning pins of the carrier

head and the pin-receiving holes, it is difficult to achieve accuracy at the level of several microns using such a mechanical positioning method. Thus, also in consideration of said shifting of the prints between the green sheets, shifting of the prints between the upper and the lower layers of the product becomes equivalent to or even greater than that of Publicly Known Example 1.

[0007]

Means to solve the problems

Accordingly, the purpose of the present invention is to present an inexpensive manufacturing method and a manufacturing device for manufacturing a ceramic multilayered component with minimal shifting between the upper and the lower layers of layered green sheets. The ceramic multilayered component manufacturing method of the present invention is characterized in that in a ceramic multilayered component manufacturing method in which prescribed internal circuits are printed on ceramic green sheets with a substrate film cut into a prescribed size, and [the sheets] are layered and crimped together into a multilayered block, the ceramic green sheets with the substrate film are provided with positional references indicating prescribed relative relationship with the internal circuit, and the positional references are photographed using cameras during the printing process of the internal circuit and the process for layering the ceramic green sheets with the substrate film in order to measure the positions by means of image processing, and the positions of the sheets with the substrate film are corrected based on said information. Furthermore, while the size of the positional references should be decided based on the relationship among the resolution, fields, and measuring accuracy of the CCD cameras, ideally, at least 2 round holes equal to or smaller than 1 mm, preferably, equal to or smaller than 0.5 mm, should be created at positions away from each other as much as possible. In addition, they do not have to be round, nor have they to be through-holes. They may be triangular, square, or cross-shaped, as long as the prescribed references can be measured unilaterally during the image processing, and the position and the posture of the green sheet with the substrate film can be computed. In addition, different positional references may be used for the internal circuit printing process and the layering process.

[0008]

In addition, the ceramic multilayered component manufacturing method of the present invention is characterized in that in a ceramic multilayered component manufacturing device having a printing means which prints a prescribed internal circuit on a ceramic green sheet with a substrate film cut into a prescribed size and a layering means which layers the ceramic green sheets and crimps them into a layered multilayered block, a marking means which provides positional references indicating prescribed positional relationship with the internal circuit on the

ceramic green sheet with the substrate film, a first measurement controlling means which measures the positions of the aforementioned positional references in order to compute the differences between the measured values and prescribed values set, a positioning means which sets the ceramic green sheet to the internal circuit printing means by moving it in such a manner that the aforementioned differences are eliminated, a second measurement controlling means which measures the positions of the references provided on the respective ceramic green sheets in order to compute the differences between the measured values and prescribed values set, and a carrier means which carries the ceramic green sheets and sets them to the layering means in such a manner that the aforementioned differences are eliminated, are provided.

[0009]

Embodiment

An embodiment of the present invention will be explained with reference to the figures. Figure 1 shows the principal manufacturing processes of the ceramic multilayered component manufacturing method in accordance with the present invention. The present manufacturing method is a non-frame process, and it solves issues pertaining to green sheet positioning accuracy. An embodiment of the ceramic multilayered ceramic component manufacturing method and the manufacturing device of the present invention will be explained with reference to the figures.

[0010]

First, a ceramic green sheet is formed on a substrate film made of polyethylene terephthalate. After the green sheet is dried, it is cut into a prescribed size while the substrate film is intact.

[0011]

Then, the cut green sheet with the substrate film is carried onto a hole puncher to create holes (hole creating process 3C). As shown in Figure 2, a prescribed number of via holes 16 with a diameter of 0.2 mm, for example, and positional reference holes 13 with the diameter of 0.2 mm serving as positional references are created in the product area of green sheet 10 with said substrate film and at 2 side parts outside of said product area, respectively, through substrate film 12 and green sheet 11. Here, the mutual positional relationship is maintained precisely when creating the holes due to the following reason. A via hole is a hole created on the green sheet while maintaining a prescribed positional relationship with respect to the internal circuit in order to achieve conductance between the layers of the multilayered ceramic component, and a conductive paste is filled therein during the subsequent internal circuit printing process. Therefore, the presence/absence of via hones 16, their positions, and the pattern to be printed for

internal circuit 14 vary depending on the green sheet used to form a specific layer. Positional reference holes 13 are created at such positions that when layered in reference to them, the via holes and the internal circuits on the respective layers create a prescribed positional relationship. When a green sheet does not need any via holes 16, only positional reference holes 13 are created. In terms of the accuracy of the holes created through substrate film 12 and green sheet 11, accuracy of the holes created on green sheet 11 is higher than that of the holes created on substrate film 12. The reason is that while green sheet 11 is made of a soft plastic material, substrate film 12 is likely to expand to create flashes. Furthermore, although aforementioned positional reference holes 13 are created using the same tool used to create the via holes, it is not necessarily the case. Therefore, as it will be described later, the size should be decided based on the relationship among the resolution, fields, and measuring accuracy of the CCD cameras. Ideally, at least 2 round holes equal to or smaller than 1 mm, preferably, equal to or smaller than 0.5 mm, should be created at positions separate from each other as much as possible. In addition, they do not have to be round, nor have they to be through-holes. They may be triangular, square, or cross-shaped, as long as prescribed references can be measured unilaterally during the image processing, and the position and the orientation of the green sheet with the substrate film can be computed.

[0012]

Next, multiple internal circuits 14 are printed on the green sheet with the substrate film and via holes using a screen-printing machine and silver paste (internal circuit printing process 4C). At this time, as shown in Figure 3, the positional relationship of the pattern of many internal circuits 14 needs to be matched precisely with the pattern of many via holes 16 created in the previous process. That is, via holes 16 need to be placed at the parts of internal circuits 14 of said layer where conductance needs to be achieved between the circuits of the upper and the lower layers. Therefore, the pattern of the internal circuits is created on the printing screen so as to match the pattern of via holes 16. Moreover, in the present example in which a concentric outer diameter greater than that of aforementioned positional reference holes 13 is used, 2 round positioning print marks with the diameter of 2 mm are provided.

[0013]

During the printing of internal circuits 14, the position and the orientation of green sheet 10 with the substrate film must be matched precisely with the printing screen. Thus, after the printing screen is set, screen-printing is first applied to a dummy sheet, respective positioning print marks 17 printed on the dummy sheet are photographed using corresponding CCD cameras 9, obtained information is input to a first measurement controlling means (not illustrated)

equipped with an image processor, and the coordinates of their center positions are obtained on the picture and stored. Here, assuming that ordinary [cameras] with 500 x 500 pixels and the viewing angle of 2 mm are used for CCD cameras 9, 4 μm per 1 pixel is obtained. whereas, fluctuation of the center of the hole is at least 4 μm or less when a known image processing technique involving a formula for approximating the hole, so that usually it can be computed at the accuracy of 1 μm or so. During the actual printing to green sheet 10 with the substrate film, the green sheet is placed on a printing table capable of controlling the positioning in X, Y, and θ directions while its surface faces upward, respective positional reference holes 13 on green sheet 10 with the substrate film, more specifically, 2 holes created on the green sheet, are photographed using 2 CCD cameras 9 from above to obtain their center coordinates through image processing, the difference from the center coordinates of positioning print marks 17 stored previously is computed, and the printing table is moved in the directions which eliminate said difference in order to proper position green sheet 10 with the substrate film. When a printing table with a positioning accuracy of 1 μm or so is used, the overall printing accuracy, including measuring accuracy, can be restricted to less than several microns. Aforementioned print marks 17 may be donut-shaped, and they do not need to be on positional reference holes 13. In addition, they do not need to be circular, and they may be triangular or square as long as the prescribed reference parts can be computed unilaterally through image processing. An example in which green sheet 10 with the substrate film completed with internal circuit printing process 4C is shown in Figure 3. As for green sheet 10 with the substrate film, many internal circuits 14 are printed at the center part of the surface of the green sheet, and line segments 15 for evaluating the layering accuracy are printed at the periphery. Substrate film 12 is attached to its back surface, positional reference holes 13 are created at 2 locations on the periphery of green sheet 11, and print marks 17 are printed concentrically to positional reference holes 13.

[0014]

Green sheets 10 with the substrate film formed with a variety of print patterns are stored in a large quantity into magazine 31 shown in Figure 4 according to each pattern. At this time, they are placed such that substrate 12 film faces downward. Furthermore, they include those which do not require any printing and those with no via holes. A front view of sheet feeding device 30 and layering device 20 out of a group of devices constituting the ceramic multilayered component manufacturing device of the present invention is shown schematically in Figure 5. Its operations will be explained below with reference to Figure 5. Once a prescribed number of green sheets 10 with the substrate film of the kinds required for making a ceramic multilayered component are all stored into magazine 31, said magazine is set to sheet feeding device 30. Sheet feeding device 30 is configured with sheet stocker 32 and sheet unloading device 33. Sheet

stocker 32 has many shelves for storing magazines 31. In the present example, they are provided in 3 stages vertically and in 8 rows concentrically in the perimeter direction, and the center shaft is linked to a motor via an attenuator. In addition, sheet unloading device 33 is configured with hoisting device 34 provided outside of sheet stocker 32 and a sheet drawing device 35 mounted on its hoisting saddle which are provided parallel to the storage shelves arranged vertically. Sheet feeding device 30 is capable of storing 24 magazines 31 (31a, 31b, ...), that is, up to 24 kinds of sheets, unloading the sheets from magazines 31 according to a prescribed layering order using the combination of the rotating operation of sheet stocker 32 and the hoisting operation of sheet unloading device 33, and supplying them to layering device 20.

[0015]

Sheets, such as a polyethylene terephthalate sheet or an expanded adhesive sheet which can be peeled off by applying heat, serving as the base for layering (will be referred to as base sheet, hereinafter) are stored in first magazine 31a of sheet feeding device 30 in advance. Sheet feeding device 30 rotates sheet stocker 32 to the position where first magazine 31a faces sheet unloading device 33, and the hoisting device of sheet unloading device 33 moves to the height where it meets the first slot of first magazine 31a. Sheet drawing device 35 draws 1 sheet from the slot by grabbing the side right in front of it in order to unload it from magazine 31a. Said drawn base sheet is vacuum-sucked by vacuum suction head 37 of sheet inverting-mounting mechanism 36, rotated by 180°, and inverted. The inverted base sheet is mounted onto lower mold 21 by carrier machine 27.

[0016]

Next, second magazine 31b housing prescribed green sheets to be layered is rotated to the position where it faces unloading device 33, and said green sheet 10 with the substrate film is drawn out and held in the aforementioned manner after it is inverted by inverting-mounting mechanism 36. The side of substrate film 12 of green sheet 10 with the substrate film held faces upward at this time. Carrier machine 27 with carrier head 22 which moves back and forth between the inverting position of said inverting device 36 and lower mold 21 of layering device 20 is provided between them. Carrier machine 27 is provided with vacuum suction head 26 whose position is controlled in 4 axial directions, namely, X, Y, Z, and θ. Said vacuum suction head 26 vacuum-sucks almost the entire surface of the substrate film 12 side of green sheet 10 with the substrate film held by vacuum suction head 37 of inverting-mounting mechanism 36 using many suction holes and moves it over 2 CCD cameras 23 provided on the way to lower mold 21. Two CCD cameras 23 photograph the edges of 2 positional reference holes 13 created on green sheet 11 in the same manner as that during the internal circuit printing process and

compute their center positions using a second measurement controlling means (not illustrated) in order to obtain the amounts of deviation of X and Y positions and orientation θ of the green sheet from its prescribed reference position based on said 2 points. Like during the internal circuit printing process, a measurement accuracy of 1 μm can be achieved. The X, Y, and θ shafts are moved in response to the amount of deviation obtained in order to correct said amount of deviation. When [cameras] with a resolution of 1 μm with respect to the X, Y, and θ shafts are used, the overall accuracy after the correction can be less than several microns (positional correction process 5C). Furthermore, the aforementioned amount of deviation can be computed also by photographing the 2 print marks printed simultaneously with the internal circuits in reference to positional reference holes 13 during the internal circuit printing process instead of positional reference holes 13 [sic].

[0017]

Subsequently, carrier head 22 is moved by a prescribed amount to the position immediately above lower mold 21, and the Z shaft is driven to lower vacuum suction head 26. Vacuum suction head 26 is attached to the movable base of the Z shaft via a gimbal spring; whereby, as vacuum-sucked green sheet 10 with the substrate film comes into contact with the sheet mounted previously, it follows the sheet mounted previously due to the function of the gimbal spring and crimped together by the force of the gimbal spring. Subsequently, when the vacuum is shut off, and vacuum-breaking air is introduced, green sheet 10 with the substrate film remains at said position. The gimbal spring is very rigid in the X, Y, and θ directions, so that [the sheet] does not shift in said directions substantially. In addition, although the layering position gets higher every time [a sheet] is layered to the extent of the thickness of green sheets 10 layered thus far, said [difference] is also absorbed by the gimbal spring. Green sheets 10 with the substrate film can be mounted while placing positional reference holes 13 precisely at the prescribed position relative to lower mold 21 in said manner. That is, positional reference holes 13 of green sheets 10 with the substrate film to be layered one after another hardly ever shift from one another. Once green sheets 10 with the substrate film are positioned precisely on lower mold 21, press 28 begins to operate to lower upper mold 25 in order to crimp them together under a prescribed pressure, temperature, and time (layering-crimping process 6C). Simple plate-like [molds] with a built-in heater may be used for the upper and the lower molds.

[0018]

As upper mold 25 of the press is raised, peeling head 24 for peeling substrate film 12 off begins to descend while rotating between the upper and the lower molds. puts an adhesive tape to the corners of substrate film 12 of the topmost layer, and ascends while rotating in the opposite

direction in order to peel said substrate film off (PET film peeling process 7C). Once the layering of a prescribed number of green sheets is completed by repeating the aforementioned series of processes, carrier head 22 vacuum-sucks the multilayered block to remove it. Furthermore, substrate film 12 on the last green sheet does not need to be peeled off because it serves as a protective film.

[0019]

The multilayered block was cut to observe the internal structure in order to evaluate the layer-crimping accuracy of the multilayered component produced using the ceramic multilayered component manufacturing method of the present invention. As for the evaluation, in order to achieve the evaluation of the layering accuracy shown in Figure 3, said block was cut perpendicularly to its main plane in the length direction of an arbitrary line segment out of line segments 15 provided in the form a of a pattern printed in the X and the Y directions, and the cross section was inspected using a microscope. The pattern of line segment 15 used for evaluating the layering accuracy was the same in all green sheets, and said line length was 100 μm. The layering accuracy can be measured while detecting a deviation by the degree equivalent to individual line segment 15. As a result, fluctuation at the center position of the cross section of the line segment was ±10 μm or less. On the other hand, when a multilayered block comprising green sheets with the same line segments 15 as those described above was created in the process utilizing the frame and inspected using a microscope in the same manner, fluctuation at the center position was very significant, that is, ±50 μm, indicating that the ceramic multilayered component produced using the present invention had better layering accuracy.

[0020]

Effect of the invention

As described above, with the ceramic multilayered component manufacturing method and the manufacturing method of the present invention, because the reference holes having a precise mutual positional relationship with the internal circuits of the respective green sheets are created, they are measured without coming into contact with them by means of image processing, and the positions of the green sheets are corrected using the high-precision carrier device based on said information, printing-related shifting of the green sheets during the internal circuit printing process and shifting between the green sheets during the layering-crimping process occur very rarely, and the fluctuation of the positions of the internal circuits of the produced ceramic multilayered component can be reduced to 20 μm or less, so that fluctuation of the electric characteristics, such as a capacitance and an inductance, can be reduced. In addition, a frame itself is no longer needed because no frame is used, the yield is improved because no parts for

pasting a frame are needed, and the efficiency can be improved in that the processes to be carried out after the framing and the frame washing processes can be eliminated, so that it can produced inexpensively.

Brief description of the figures

Figure 1 shows the primary process in accordance with the ceramic multilayered component manufacturing method of the present invention.

Figure 2 is a slanted view of the ceramic green sheet after the holes are created.

Figure 3 is a slanted view of the ceramic green sheet after the printing is completed.

Figure 4 shows the magazine.

Figure 5 is a schematic front view of the layering device and the sheet feeding device constituting a part of the ceramic multilayered component manufacturing device of the present invention.

Figure 6 shows the manufacturing processes of the ceramic multilayered component during the process utilizing a frame.

Explanation of the reference symbols

9 … CCD camera; 10 … ceramic green sheet with substrate film; 11 … ceramic green sheet; 12 … substrate film; 13 … positional reference hole; 14 … internal circuit; 15 … line segment for layering accuracy evaluation; 20 … layering device; 21 … lower mold of press; 22 … carrier head; 23 … CCD camera; 24 … peeling head; 25 … upper mold of press; 26 … vacuum suction head; 30 … sheet feeding device; 31 … magazine; 32 … sheet stocker; 33 … sheet unloading device; 34 … hoisting device; 35 … sheet drawing device; and 36 … inverting-mounting mechanism.

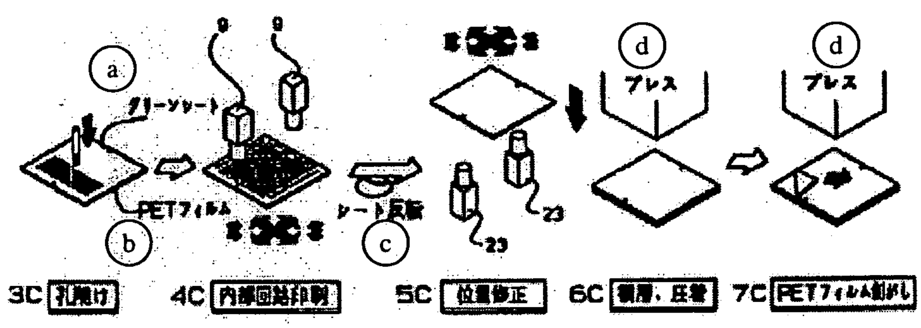

Figure 1

Keys: a Green sheet
b PET film
c Sheet inversion
d Press

3C Hole formation
4C Internal circuit printing
5C Positional correction
6C Layering/crimping
7C PET film peeling

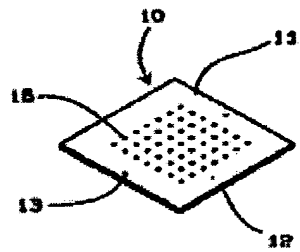

Figure 2

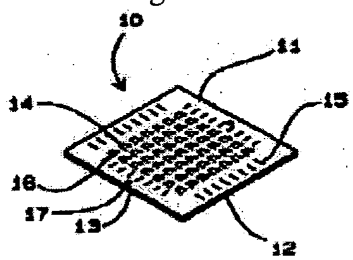

Figure 3

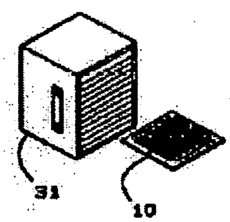

Figure 4

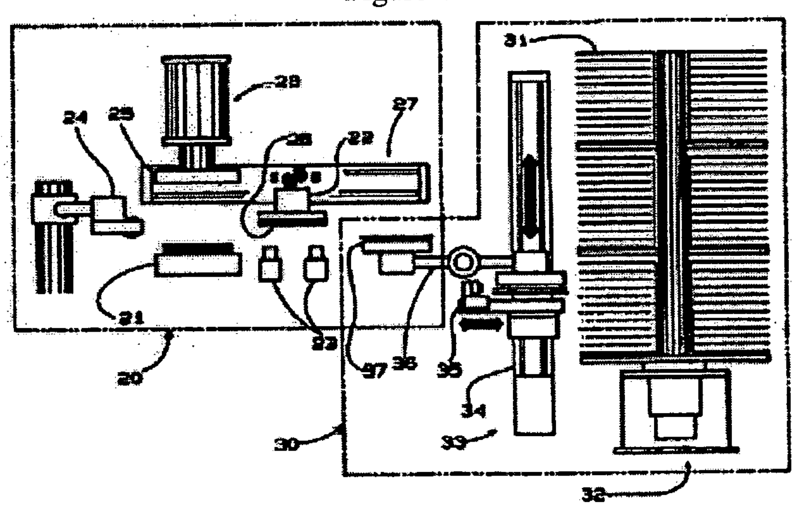

Figure 5

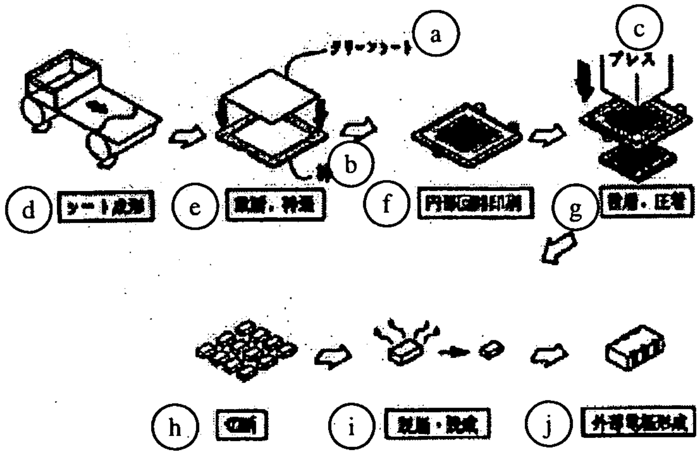

Figure 6

Keys:

Keys:	a	Green sheet
	b	Frame
	c	Press
	d	Sheet formation
	e	Cutting/framing
	f	Internal circuit printing
	g	Layering/crimping
	h	Cutting
	i	Degreasing/normalizing
	j	External electrode formation